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13. ABSTRACT (Maximum 200 words)

The specific aims of this study are to develop and validate computational methodologies to characterize regional geomorphology at multiple scales using remote sensing data. A University of Texas portion of the study focuses on the remote sensing computations, and our portion focuses on paleohydrological and geomorphological interpretations. In the University of Arizona portion of the project, we found that the quantitative remote sensing imagery provided key data on gradients and patterns of past floods (paleofloods). We were able to use these data in quantifying the paleohydraulic parameters of rare, high-energy floods, particularly in the arid landscapes of Australia and Arizona.

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Sincerely,

Victor R. Baker, Ph.D.

FINAL PROGRESS REPORT

University of Arizona Portion of
"Multisensor Approach to Mapping of 2D and 3D Geologic
Features from Remotely Sensed Imagery"

ARO Research Agreement #DAAG55-98-1-0426

Foreword:

This project involved complementary efforts at the University of Texas at Austin and at the University of Arizona. The report on the remote sensing computations has been provided separately as the Final Progress Report from the University of Texas at Austin. The following report addresses regional geomorphology and paleohydrology results generated by portion of the project at the University of Arizona.

Statement of the Problem:

This study was aimed at developing and validating computational methodologies to characterize regional geomorphology using remote sensing imagery. Our portion of this study (University of Arizona) was focused on geomorphological interpretation of riverine features in Australia and Arizona. We were specifically focused on cataclysmic flood features and related aspects of geomorphology and paleoflood hydrology.

Summary of the Most Important Results:

In the University of Arizona portion of the project (geomorphic and paleohydrologic interpretation) we found that the quantitative remote sensing imagery provided key data on gradients and patterns of past floods (paleofloods). We were able to

use these data in quantifying the paleohydraulic parameters of rare, high-energy floods, particularly in the arid landscapes of Australia and Arizona. From the reconstructed discharges of the ancient floods we could show that critical values of stream power per unit area were achieved that induced significant bedrock erosion. Moreover, the very high-resolution remote sensing imagery and feature-recognition algorithms developed at the University of Texas at Austin allowed us to document the associated erosional and depositional patterns.

Whereas alluvial rivers adjust readily to formative discharges of moderate magnitude and frequency. Bedrock river channels present various thresholds to effective channel adjustment, such that only relatively rare, high-magnitude flood discharges contribute to shaping their morphologies. Very high values of power per unit area of bed, exceeding 10^2 Wm^{-2}, result in high-energy erosional processes, including cavitation and macroturbulent plucking. Although these processes are best exemplified in the Channeled Scabland and other late Pleistocene cataclysmic flood channels, they also can be achieved in modern bedrock gorges where very resistant rocks are acted upon by unusually large floods. Examples include various bedrock river channels in Arizona and northern Australia. Distinctive scabland-like morphologies occur, including wide, shallow bedrock surfaces with inner channels and narrow, deep gorges. As in alluvial rivers, there may be an adjustment to energy expenditure, but at a much higher level of energy associated with rare floods.

The procedures developed in this study; employing quantitative topographic surveys from radar altimetry and multispectral imagery analysis, contribute to our ability to achieve paleoflood hydrology. The latter studies past or ancient flow events that

occurred before direct measurement by modern hydrological procedures. Effects of ancient floods on natural recording systems may include flood deposits, damage to vegetation (botanical paleoflood data), and erosion of channel-margin materials. Flood stages recorded naturally (paleoflood data) are transformed by hydraulic theory at the sites where the flood effects are indicated to generate water-surface profiles for the corresponding paleoflood discharges. As a practical matter, in the public debate over responses to potential hazards, the documented occurrence of an ancient (but real) cataclysmic process is likely to have more impact than is discussion of various hypothetical frequency distributions. Thus, the confirmation of a flood design number with paleoflood data is not merely proper science; it also serves to increase public confidence in any proposed solution that ultimately will lead to great economic or social expense for hazard mitigation.

LISTING OF PUBLICATIONS

(a) Papers in Peer-Reviewed Journals

Baker, V.R., 2002, The study of superfloods: *Science*, v. 295, p. 2379-2380.

Baker, V.R., 1998, The role of extreme floods in shaping bedrock channels: *American Geophysical Union Monograph* 107, p. 153-165.

(b) Papers in Conference Proceedings and Edited Volumes

Baker, V.R., 2000, Paleoflood hydrology and the estimation of extreme floods, in Wohl, E.E., editor, Inland Flood Hazards: Cambridge University Press, Cambridge, p. 359-377.

Baker, V.R., 2000, Paleohydrology and the hydrological sciences, in Benito, G., Baker, V.R. and Gregory, K.J., editors, Palaeohydrology and Environmental Change: Wiley, Chichester, p. 1-10.

(c) Papers Presented at Meetings, Published as Abstracts

Baker, V.R., 2002, Catastrophic floods: Scientific understanding and continuing human ignorance, in Environmental Catastrophes and Recovery in the Halocene: Brunel University, London, p. 12-13.

Baker, V.R., 2002, A bright future for old flows: origins, status and future of paleoflood hydrology, in Palaeofloods, Histroical Data and Climatic Variability: Applications in Flood Risk Assessment: Book of Abstracts: Univ. Barcelona, Spain, p. 3.

Baker, V.R., 2001, Cataclysmic flooding and the natural histories of great river systems, in Abstracts Volume: International Conference "Intracontinental Palaeohydrology and River Valley Geomorphogenesis": Krasnoyarsk State University, Krasnoyarsk, Russia, p. 14.

Baker, V.R., 2001, Seeking understanding and consilience in the study of superfloods: Geological Society of America Abstracts with Programs, v. 33, no. 7, p. A145.

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Baker, V.R., 2000, Geological understanding of floods: Geological Society of America Abstracts with Programs, v. 32, no. 7, p. A459.

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Baker, V.R., 1999, Understanding rare, high-energy floods, in Abstracts of the International Conference on Drainage Basin Dynamics and Morphology: The Hebrew University, Jerusalem, Israel, p. 4.

Baker, V.R., 1998, The three kinds of geoscience modeling, in Conference Abstracts: New directions in Desert Surficial Processes and Landscape Dynamics on Military Lands: Desert Research Institute, Reno, Nevada, p. 24.

Baker, V.R., 1998, Global change and global continental paleohydrology, in Abstracts of the Conference Papers, Third International Meeting on Global Continental Palaeohydrology, GLOCOPH '98: Rissho University, Kumajaya, Japan, p. 5.

Baker, V.R., 1998, High-energy megafloods: Erosion, sediment transport, and sedimentation, in Abstracts of the 15th International Sedimentological Congress: International Association of Sedimentologists, Alicante, Spain, p. 167.

(d) Manuscripts Submitted but Not Yet Published

Baker, V.R., in press, Paleofloods and extended discharge records, in Gregory, K.J. and Benito, G., editors, Palaeohydrology: A Contribution to Global Change: Wiley, Chichester.

Baker, V.R., in press, Floods and other catastrophic events, in Middleton, G., editor, Encyclopedia of Sedimentology: Kluwer, Dordrecht.

PARTICIPATING SCIENTIFIC PERSONNEL

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